Decentralized power generation in Indonesia
Current issues and prospects

Abstract

The Government encourages the use of new and renewable energy to create energy security in the long term. Indonesia is an archipelago with a load and power generation spread unevenly across the country and electricity interconnection is still limited. It is therefore necessary to search a breakthrough in new and renewable energy through decentralized power generation. The power plants that can meet the needs are small-scale coal power plants, micro-hydropower, small scale geothermal and solar home systems. Decentralized power generation development will need policies to support the dissemination of technology.

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Introduction

The success of development in Indonesia will encourage increased use of electricity. In order to continue the development progress it needs to be supported by the availability of reliable power generation at affordable prices. The availability of reliable and affordable electricity to the remote area is the main condition for improving living standards, so that the entire region can be developed together.

The use of electrical energy in Indonesia is about 7.6% of the total energy demand in 2008 and reached 1032 MBOE, with around 60% of the total demand located in Java itself. The electrification ratio is still low at about 62.8%. Households that do not have electricity connection yet are generally scattered and are far from centres of electricity demand. To increase the electrification ratio, it is necessary to develop power plants based on the local resources.

Since Indonesia has limited and depleted oil reserves, it is necessary to develop other energy sources, such as, coal, natural gas and renewable energy to increase the national energy security. In order to increase energy security in the long term, the Indonesia government should encourage the use of new and renewable energy resources (biomass, solar, geothermal, wind, hydropower, nuclear and others) as alternatives for power plants. Related to the above, Indonesia Government has declared the National Energy Policy, with regard to reducing the use of oil and finding it's substitution with energy alternatives. But the development of energy alternatives still has many obstacles, especially about high generating costs by use of renewable resources.

In the past twenty years, electricity generation in Indonesia is dominated by large-scale power plants. Large-scale power plants in Java are mostly coal-fired power plants with a capacity of about 400-600 MW. Considering the geographical condition of Indonesia as an archipelago, with the demand and power plant distribution unevenly distributed across the region and electricity interconnection still limited, it is necessary to make a breakthrough in local energy generation. It is necessary to adopt electricity decentralisation policy to improve local energy independence. Local electricity generation must prioritize use of local energy resources that would be expected to be more economical since transportation/distribution costs would get reduced. This will improve local energy security and ensure sustainability of economic development.

Current scenario of energy in Indonesia

Before discussing more about the decentralized power generation, energy issues in general will be presented

first. The electricity sector is closely related to the availability of energy resources.

Energy resources

Oil resources in Indonesia are estimated to be 56.6 billion barrels, with proven reserves of about 8.4 billion barrels (Table 1). With the oil production level in the year 2007 approximately 348 million barrels per year, it is estimated that the reserves will be exhausted within the next 24 years, if there are no new reserves discovered. Natural gas resource at the same time is approximately 334.5 TCF with a proven reserve of about 165 TCF. With a production rate of approximately 2.79 TCF in 2007, it is estimated that gas reserves will be exhausted within the next 59 years. While coal reserves are estimated at about 90.5 billion tons, the proven reserves estimate is of 18.7 billion tons. If the production rate was constant at 201 million tons as in the year 2007, it is estimated that the reserves will be exhausted in 93 years.

Unlike fossil energy sources that have been widely used, renewable energy resources such as hydropower, geothermal, biomass, solar, and wind energy, have not been intensively utilized. The hydropower potential of 75.67 GW has been utilized at about 4.2 GW or around 6% of the total potential (Table 2). Geothermal potential of 27 GW is currently utilized for only about 1.2 GW. The remaining potential of both hydropower and geothermal is relatively large. Other renewable resources such as, biomass, solar and wind energy potential is still abundant and not yet utilized optimally. In addition to above energy resources, it is estimated that a quarter of Indonesia's land contains radioactive mineral deposits, especially uranium which could be used as fuel for nuclear power plants in future. Renewable energy sources have great potential for use in electricity generation. But until now utilization of renewable energy is very small, because there are some constraints in terms of technology and financing. Therefore, there is urgent need to push the government policy in order to make the renewable resources compete with fossil fuels for energy generation.

Fossil energy	Resource	Reserve	Production	RP ratio (year)
Oil	56.6 billion barrel	8.4 billion barrel*	348 million barrel	24
Gas	334.5 TSCF	165 TSCF	2.79 TSCF	59
Coal	90.5 billion ton	18.7 billion ton	201 million ton	93
Coal Bed Methane	453 TSCF	-	-	-

Table 1. Fossil energy resources

*Including Cepu Block

Source: Department of Energy and Mineral Resources (2007)

Non fossil energy	Resource	Installed capacity
Hyropower	75.67 GW (e.q. 845 MBOE)	4.2 GW
Geothermal	27.00 GW (e.q. 219 MBOE)	0.992 GW
Mini/Micro-hydropower	0.45 GW	0.084 GW
Biomass	49.81 GW	0.3 GW
Solar energy	4.80 kWh/m2/day	0.008 GW
Wind energy	9.29 GW	0.0005 GW
Uranium	3 GW (e.q. 24.112 ton) for 11 years*	30 MW

Table 2. Non-fossil energy resources

*Only in Kalan, West Kalimantan

Source: Department of Energy and Mineral Resource (2007)

National electricity

Power plants in Indonesia can be classified based on their utilization, i.e., the public use or own use. Electricity generation for public use is largely supplied by state electricity company (PT PLN Persero) and partly supplied by private companies, often called IPP (Independent Power Producers), and cooperatives. While electricity generation for its own use, often called captive power, is undertaken by the private sector to meet its own demand that is usually not covered by national electricity network or for system reliability reasons.

Installed capacity of power plants of PT PLN Persero until the year 2008 reached 30.2 GW. While power generation capacity of private companies and captive power is estimated to reach approximately 40% of the total power plants of PT PLN. Installed capacity of captive power is likely to continue declining in the long run, because more efficient generation of electricity from PT PLN is likely. Most of PLN's power plants are using coal (40%) and gas (36%). The rest use hydropower (12%), diesel (10%), and geothermal (3%). The wind power generation is still of very small amount. Development of installed capacity of power plants of PT PLN Persero is shown in Figure 1.

Electricity production of PT PLN Persero in 2008 is 149 TWh that consists of its own production of 118 TWh and purchase of 31 TWh. The PT PLN Persero sold 129 TWh of electricity in 2008. Sale for household sector was 50 TWh, for industrial sector 48 TWh, for business sector 23 TWh, and social & other sectors 8 TWh. The biggest electricity consumer is the household sector. It means that electricity is still used mostly for consumption rather than for production.

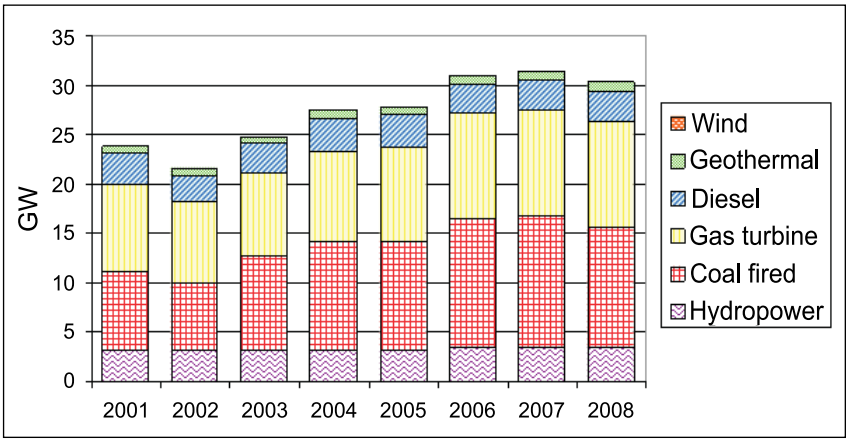

Fig 1. PLN installed capacity

Policies

To encourage the utilization of new and renewable energy, the government issued Presidential Regulation No.5 in National Energy Policy in the year 2006. The policy has emphasized two points i.e., energy diversification and energy conservation. Energy diversification policies intended to reduce oil use by 20% in 2025 and increase the use of new and renewable energy by 17% in 2025. Meanwhile, energy conservation policy is to reduce the elasticity of energy below 1 in the year 2025 to improve energy efficiency in all sectors. New and renewable resources will be developed that includes biofuel biomass, geothermal, nuclear, hydropower, solar power, wind power and liquefied coal. The policy is the first national energy policy with detailed and comprehensive description of time bound utilization of various energy types. Along with the electricity supply crisis in some areas in Indonesia in the last 5 years, the government issued the program to build 10,000 MW power plant, or known as acceleration program phase I. Acceleration program stipulated in Presidential Regulation No. 71 year 2006 to improve electricity fuel mix is mainly using coal. A part of project funding is carried out by the private sector as independent power producer (IPP). The program is followed by phase II, by adding another 10,000 MW and improvement of fuels mix into hydropower and geothermal that could reduce electricity subsidy.

So far the government has enacted 5 legislations on energy and mineral resources, i.e., law on oil and gas, law on geothermal, law on energy, law on minerals and coal, and the last is law on electricity.

To increase development of power plants using renewable energy and to strengthen small and medium scale businesses and enterprises, the State Minister of Energy and Mineral Resources has issued Law No. 002 in the year 2006 for medium scale power plant to use renewable energy. This policy obliges PT PLN Persero to buy electricity from medium scale enterprises that use renewable energy. The policy regulates electricity sale to the network up to 1 MW at a price of 0.8 and 0.6 of generation cost.

In 2007, the government issued law No. 30 that mandates the central government to prepare national energy planning (RUEN) and the regional government to prepare regional energy planning (RUED). In order to prepare RUEN, the central government will analyze all inputs with regard to local government needs and opinions from stakeholders. While in preparing RUED local governments should refer to RUEN. Energy law is expected to be a driving force for optimal and sustainable energy development. In addition to the energy law, the government has also issued Law No. 30 in the year 2009 on electricity. The law eliminates monopoly of PLN electricity business and increases the role of local governments to establish electricity systems and local rates. So far the government has enacted 5 legislations on energy and mineral resources, i.e., law on oil and gas, law on geothermal, law on energy, law on minerals and coal, and the last is law on electricity.

Decentralized power generation

Taking into account current conditions of energy resources and electricity sectors one could forecast long term development alternatives.

Electricity demand forecast

Generation capacity additions depend on the level of demand growth that is influenced by economic growth, electrification ratio targets, and electricity substitution from captive power to PT PLN Persero or IPPs. Based on study prepared by BPPT (2009), economy will grow at about 6.5% per annum in the period 2008-2025 as high-end scenario. GDP will grow from 2,080 trillion rupiah in 2008 to 5,897 trillion rupiah in 2025. While population growth will increase at an average rate of 1.1% per annum from 228 million in 2008 to 273 million by the year 2025. Along with success in increasing electrification ratio and development of electricity infrastructure in all regions, the electricity demand will increase by 7.5% per year during the period 2008-2025. Electricity demand will increase from 149 TWh in 2008 to 475 TWh in 2010 (Figure 2). Utilization of electricity in the industrial sector is estimated to be more efficient so that prices of products can be more competitive.

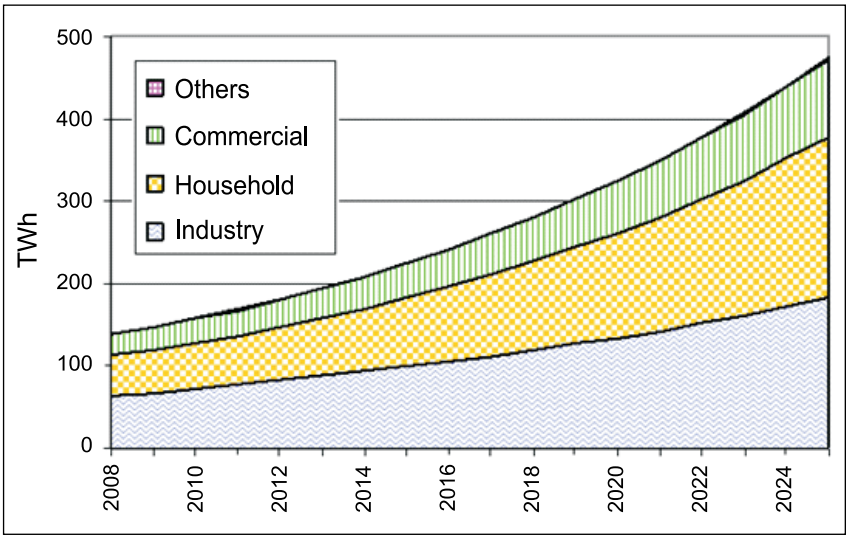

Fig 2. National electricity demand forecast

Total national installed capacity (PT PLN Persero and IPPs) is estimated to increase by an average growth rate of 7.6% per year from 30 GW in 2008 to 102 GW in 2025. Power generation technology is dominated by coal fired power plant for capacity addition during the period 2008-2025 i.e., 63 GW. The other is geothermal power plant with capacity addition of 3 GW in the same period. In addition, there is a plan to increase capacity of gas turbines and hydropower power plants. Capacity additions as targeted are shown in Figure 3.

Prospects for decentralized power generation

Electricity interconnection transmission networks in Indonesia are only in Java, Sumatera, and a small part of Sulawesi and Kalimantan. In Java interconnection is with West Java to Bali through Central Java and East Java, so that production in each region can be distributed to other regions.

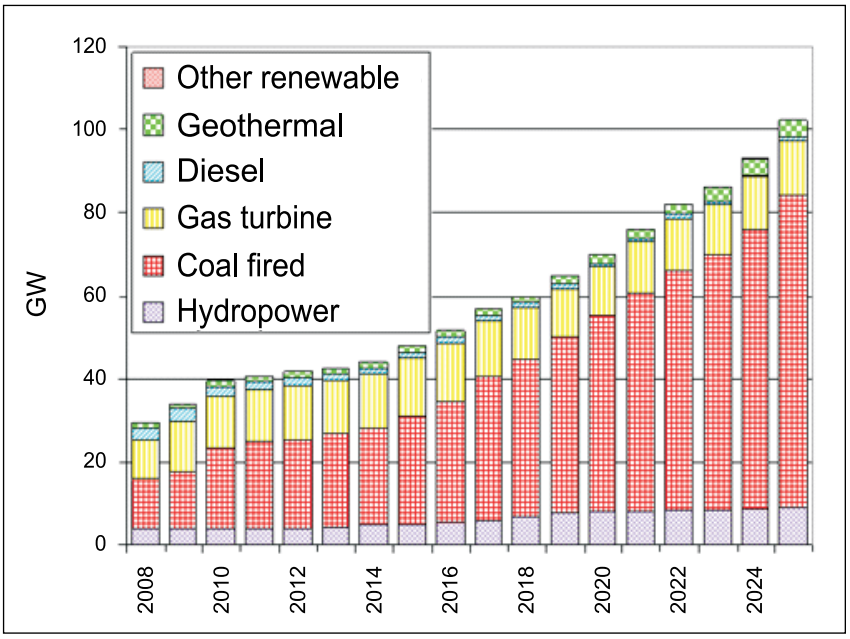

Fig 3. Installed capacity additions

In Sumatera, the interconnection grid is still divided into north grid and south grid and it has not yet been connected to the entire region. Only parts of Kalimantan and Sulawesi are connected by transmission grid. With regard to Indonesia being an archipelago country, small and isolated electricity supply systems have good chances for development. The isolated systems are often called decentralized power generation which lead to the use of local energy resources.

One of the government's programs to develop decentralized power generation is the energy independent village (EIV) program, to elevate the capability of each village so that they meet at least 60% of their energy demand themselves. The EIV program began in late 2007 with 140 villages as a pilot project and became 2000 villages at the end of 2009. There are two types of EIV. First, based on non-agricultural energy sources such as solar, hydro and wind energy; and second, based on agricultural energy sources such as biomass and biofuels that come from agricultural and forest product. Development of EIV program is an integrated program associated with productive economy to reduce poverty, create new jobs, and find substitutes for fossil fuels. The main constraint of the EIV program expansion is funding, because 95 percent depends on central government. The contribution of public or private sector is less than 5 percent. With such constraints, the government pushes private sector to go for decentralized power generation. Technologies that have potential to be developed are small-scale coal fired power plants, small-scale coal/biomass gasification, bioethanol, biodiesel, microhydel, small-scale geothermal, wind and solar home systems. These will be briefly discussed here.

• Small-scale coal fired power plant

Small-scale coal fired power plant is expected to replace the diesel power plants outside Java. This plant is an

alternative to replace power plants that use oil fuel in small-scale systems to reduce the cost of systems operation. Coal used as a fuel is of low quality which previously had low economic value, therefore, there is need to develop and improve low quality coal mining activities. Small-scale coal fired power plant can be developed based on national technology capability, so that could encourage the development of local industries which would have impact on national industry development, especially for the power plant components industry. This development will create self-reliance in national power generation industry.

• Micro hydropower plant

Micro hydropower plant is on-site utilization of water resources that are isolated and scattered and thus are more competitive than electricity from grid connection. Micro hydropower technology recently is in the stage of technology dissemination that is proven, reliable and economically feasible for certain conditions. But micro hydropower development is not adequate and feasible if not supported by the climate investment and financing. Therefore, there is a need to step up standardization of generating units and increase domestic industries capability to achieve economic benefit and economy of scale for local components production.

• Small scale geothermal power plant

Geothermal is a renewable energy source that is environment friendly compared to fossil energy sources such as oil, gas, and coal. Geothermal energy utilization for electricity generation in Indonesia has been done for the last about 30 years. As per Law No. 27 of the year 2003 about geothermal energy, local government involvement in geothermal development is very intense at both the policy and technical level. Investors, who are interested in developing geothermal power plants, now have incentives such as import duty exemption for goods needed for exploitation activities and also fiscal incentives.

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• Solar home system

Solar energy in Indonesia is quite large and reaches 4 to 5 kWh/m^2, but the efficiency of solar photovoltaic cell has only reached 10%. Since investment cost of solar PV is very high, although fuel cost is zero, the electricity generation from solar energy is less competitive compared to other energy resources. However, solar power in the form of solar home system was and will be utilized in remote areas, which have no other alternative sources for electricity generation. Assessment of solar home system technology in Indonesia has been started since 1978 for irrigation pumps that have funding assistance from Germany. Today, solar home system technology has reached dissemination stage through a 50 MWp national rural electrification program for remote areas. The target of this program is providing electricity infrastructure in rural area so that increased national electrification ratio rapidly. In addition this program also supported domestic manufacturing industry to be a commercial solar industry. The program is supported by variety of funding such as foreign funds, revolving funds, and national budget, through grant, soft loan or special funds.

• Hybrid power plant

Supply of electricity in the small islands and remote areas generally uses diesel power plant. Diesel power plant has a main obstacle that is high operational costs due to use of oil fuel that is more expensive in the remote areas. In addition, load variations during day and night operation cause a low efficiency of diesel power plant. The operational costs could reduce using hybrid power plants which combine diesel power plants with renewable energy, such as wind turbine, microhydro and/or photovoltaic. The purpose of the integration is to improve reliability and reduce operational costs due to transportation fuel and high fuel prices in remote areas. Until now at least 14 hybrid power plant pilot projects using 25 kW capacity of diesel power plant and 8 kWp capacity of solar home system have been installed in Indonesia.

• Biomass power plant

Biomass power plant assessment was conducted by feasibility study using a multi-fuel biomass cogeneration plant. This system is intended to supply heat in rural areas through biomass-fueled furnace combined with utilization of waste heat for power generation using Sterling engines. Generation scale of the study is about 1 kW for household. Assessment of biomass gasification technology using husks and peat waste has been implemented through Bioner technology with multiple demonstration stages of 25 kVA diesel generator. Although engineering improvements are still necessary, this technology has the potential for substituting diesel fuel to 75% besides other benefits such as reduced exhaust gas that have impacts on the environment. Biomass gasification technology assessment with coconut waste feedstock is also being done for 40 to 50 kVA capacity of diesel power plant.

• Wind power plant

Geographically, Indonesia's territory is located in tropics region across the equator. Wind energy potential in Indonesia essentially is smaller than in sub-tropical countries. Tropical regions generally have low potential of

wind energy with wind speeds lower than the cut-off speed, i.e. 3 m/s, the speed that can generate electricity. In addition, areas with wind speeds greater than 3 m/s is very limited in areas such as Nusa Tenggara region, but its frequency is quite rare.

• Wave power plant

Based on theoretical estimates, along the west coast of Sumatra Island and the south coast of Java Island to the southern islands of Nusa Tenggara the wave power potential is 20 kW per meter of shoreline. Wave power conversion technology assessment has reached pilot project stage using tapered channel with 1 MW capacity. In addition, recently a detail design of oscillating water column technologies for wave power plant has been developed.

Conclusion

Development of small-scale power plants needs support on non-technology aspects, such as economic policy so that dissemination of development can be realized. The fiscal policy instruments to facilitate the projects implementation of both central or regional level should be created. Incentives are needed in the form suspension of tax incentives, value added tax exemption, import duty exemption to companies that invest on renewable energy and energy conservation business. Other incentives related to energy conservation and renewable energy utilization can be a tribute to the outstanding business. These include elimination of luxury tax, and interest free loans for engineering development of energy infrastructure.

Development of geothermal power plant which has high investment costs, risks in exploration stage and long period of commercial time need policy support to reduce the investment risk level, a conducive tax system, short licensing process, and mutually profitable electricity trading scheme. Development of solar home system needs financing schemes and policy for its manufacturing and deployment, so that it will improve dissemination of solar home system as small-scale power plants in remote areas. Meanwhile, development of microhydro power plant which is a relatively well-established technology needs support on distribution process thus increasing economically attractiveness of microhydro power in remote areas.

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Asia Solar Energy Initiative

The Asian Development Bank (ADB) has launched the Asian solar energy initiative to generate some 3,000 megawatts of solar power over the next three years. The Asia Solar Energy Initiative (ASEI) aims to identify and develop large capacity solar projects that will generate some 3,000 MW of solar power by 2012.

The ASEI will make available a range of projects, and finance and knowledge sharing mechanisms, so as to attract commercial banks and the private sector to invest in these projects. In addition to direct financing, ASEI will set a target of raising $500 million from donor countries to “buy down” the high up-front capital costs of investing in solar energy, as well as design other innovative ways to attract private-sector investment. ASEI will also establish and host the Solar Energy Forum, an international knowledge-sharing platform that will track solar development projects, discuss new solar power proposals and incentive mechanisms, and organize major conferences.

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